



NASA STTR 2005 Phase I Solicitation

T4.02 Space Science Sensors and Instruments

Lead Center: GSFC

Sensors and Instruments for space science applications are:

Analytical Instrumentation

Technical innovations are sought for sensitive, high-precision, analog electronics for measurements of low voltages, currents, and temperatures. Work on cryogenic transition edge detection techniques for X-ray astronomy in particular, and IR sensors with high quantum efficiency. New robust, efficient integration techniques that are scalable to commercial manufacturing efforts are sought.

- High-resolution IR sensors with high quantum efficiency, especially novel ion-implanted silicon devices, and arrays. Sensitivities better than 10⁻¹⁶ W per root Hz;
- Cryogenic devices, such as SQUID amplifiers and SQUID multiplexers, superconducting transition-edge temperature sensors, and miniature, self-contained low-temperature He refrigerators;
- Analog application-specific integrated circuits (ASICs) with large dynamic range (>10⁵) and low power (
- Novel packaging techniques and interconnection techniques for analog and digital electronics.

Optics

Larger telescopes in space (compared to the 6 m James Webb Space Telescope) demand lighter weight materials and new concepts. For example: designs including inflatable structures for lenses, mirrors, or antennas. Order of magnitude increases are envisioned. Applications of new materials could bring a new dimension to astronomy.

Goals for future NASA Optical Systems

	X-ray Mirrors	UV Mirrors	Visible Scanning	Lidar Telescope	NIR* Earth Science Systems	Far Infrared to submillimeter Wavelength
Energy Range	0.05-15 keV	100-400 nm	400-700 nm	355-2050 nm	0.7-4 mm	20-800 mm
Size	1-4 m	1-2 m	6-10+ m	0.7-1.5 m	3m-4 m	10-25 m
Areal Density	2/grazing incidence	2	2	2	2	2

Surface Figure	1/150 at $\lambda = 633$ nm	Diffraction Limited at $\lambda = 300$ nm	1/150 at $\lambda = 500$ nm	1/10 at $\lambda = 633$ nm	1/75 at $\lambda = 1$ mm	1/14 at $\lambda = 20$ mm
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* Near-infrared

- Large-area, lightweight (2) focusing optics, including inflatable or deployable structures;
- Novel laser devices (e.g., for lidars) that are tunable, compact, lower power and appropriate for mapping planetary (and lunar) surfaces. Future lidar systems may require up to ~1.5 m optics and novel designs; and
- Fresnel-zone X-ray focusing optics to form large X-ray telescopes with small apertures but high angular resolution-better than 1 milli-arc-second. Besides newly developed optics, these missions will require formation flying of spacecraft to an unprecedented level.

Mars and Lunar Initiative Technologies

The new Exploration Initiative (Code T) will embark upon an ambitious plan of robotic and human exploration of Mars with intermediate work to be done on the Moon. A broad program of analysis and resource identification is being planned, including X-ray and Gamma-ray spectroscopy. Exploiting the existing resources will be an important part of these initiatives rather than moving resources from place to place. These resource investigations will be conducted from orbit and from landers, both of which have differing requirements. On missions to Mars and other planets, instruments are typically limited to ~5-10 kg maximum.

- Low-weight, high throughput X-ray diffraction systems at 60 keV so that sample spectra can be accumulated in minutes or hours, not days;
- Laser-based X-ray generators (up to 60 keV), both compact and lightweight;
- Improved scintillator resolution for Gamma-rays up to 10 MeV; and
- High spatial resolution X-ray detectors, for producing ~50 meters or less maps from orbiting spacecraft, also with high throughput.

Computing

Massively parallel computer clusters for ever more complicated problems (in General Relativity, electrodynamics and "space weather," for example) are becoming more important. Ways to increase performance and reliability and lower cost are called for.

- Novel computing techniques for simulations (including hydrodynamics, stellar evolution, general relativity calculations, etc.);
- New high-performance, low-cost, reliable massively-parallel computers (i.e., Beowulf clusters); and
- Validation tools and software for space weather simulations and modeling.

UAV and Balloon-craft Technologies

Both remotely piloted (unmanned airborne vehicles) and balloon instrumentation technologies are sought. New techniques and materials for forming "super-pressure" balloons and ways of formation flying or station-keeping with balloons would enable new science from this inexpensive platform, especially in the unmanned exploration of other planets.

- Super-pressure balloon manufacturing technologies;
- Station-keeping and trajectory control devices for balloons;
- New architectures and technologies for remote sensing applications; and
- Trajectory simulation tools and software.

